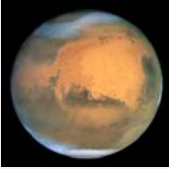
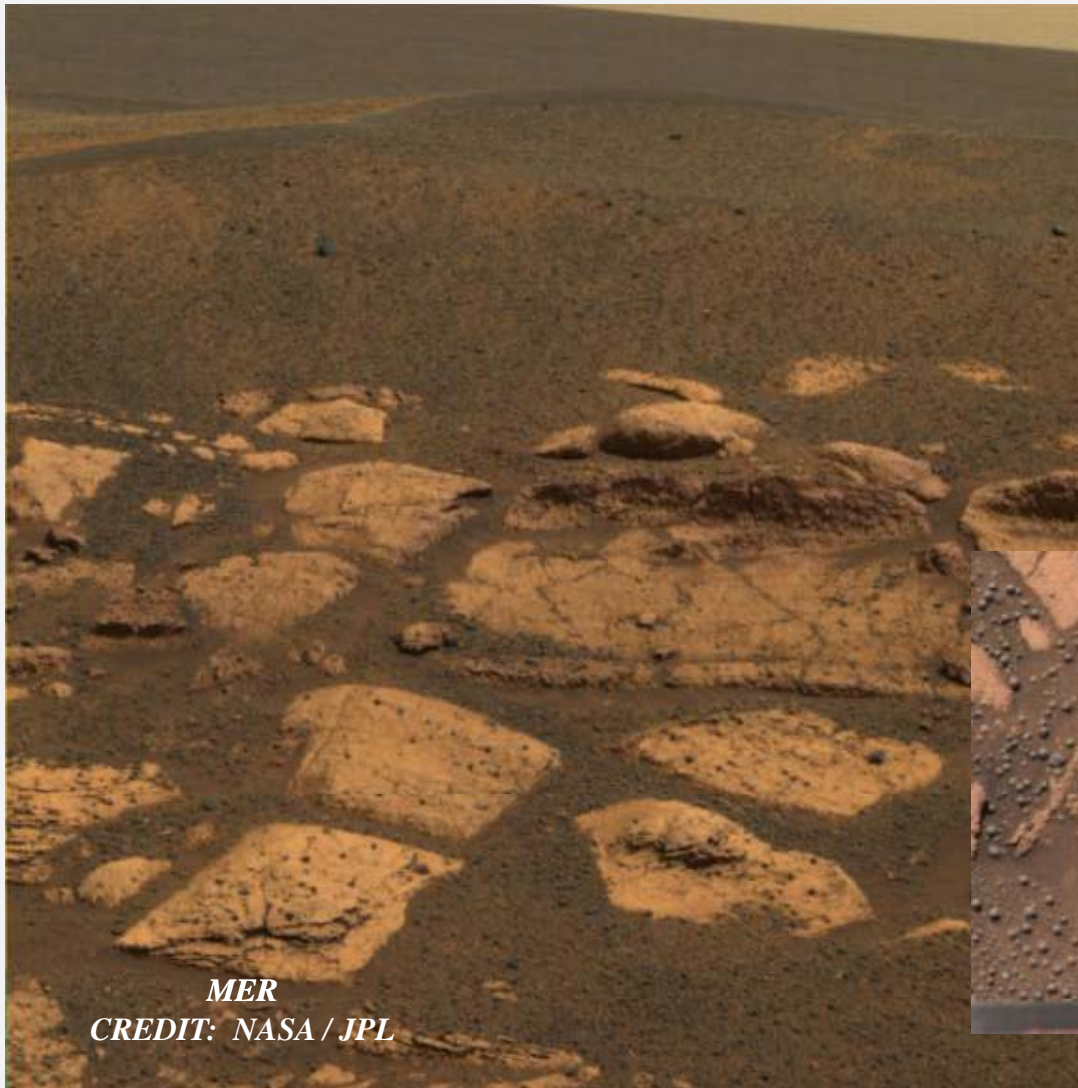


# *Opportunity: Eagle Crater*



*Solar System Exploration @ 50*



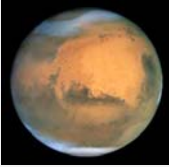
*MER*  
*CREDIT: NASA / JPL*

Martian  
“Blueberries”

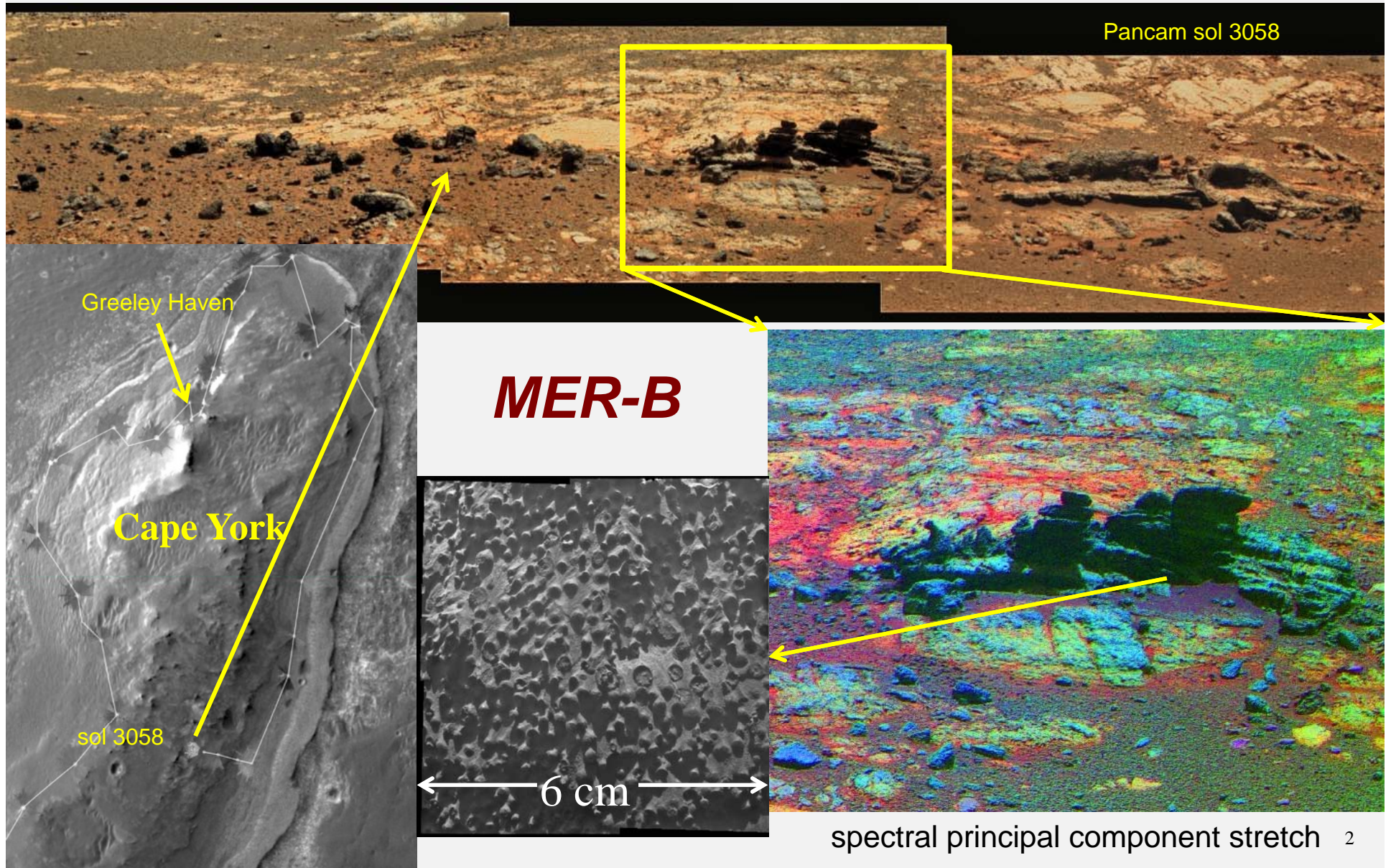




# Opportunity at Endeavour Crater

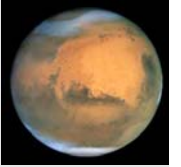


Solar System Exploration @ 50

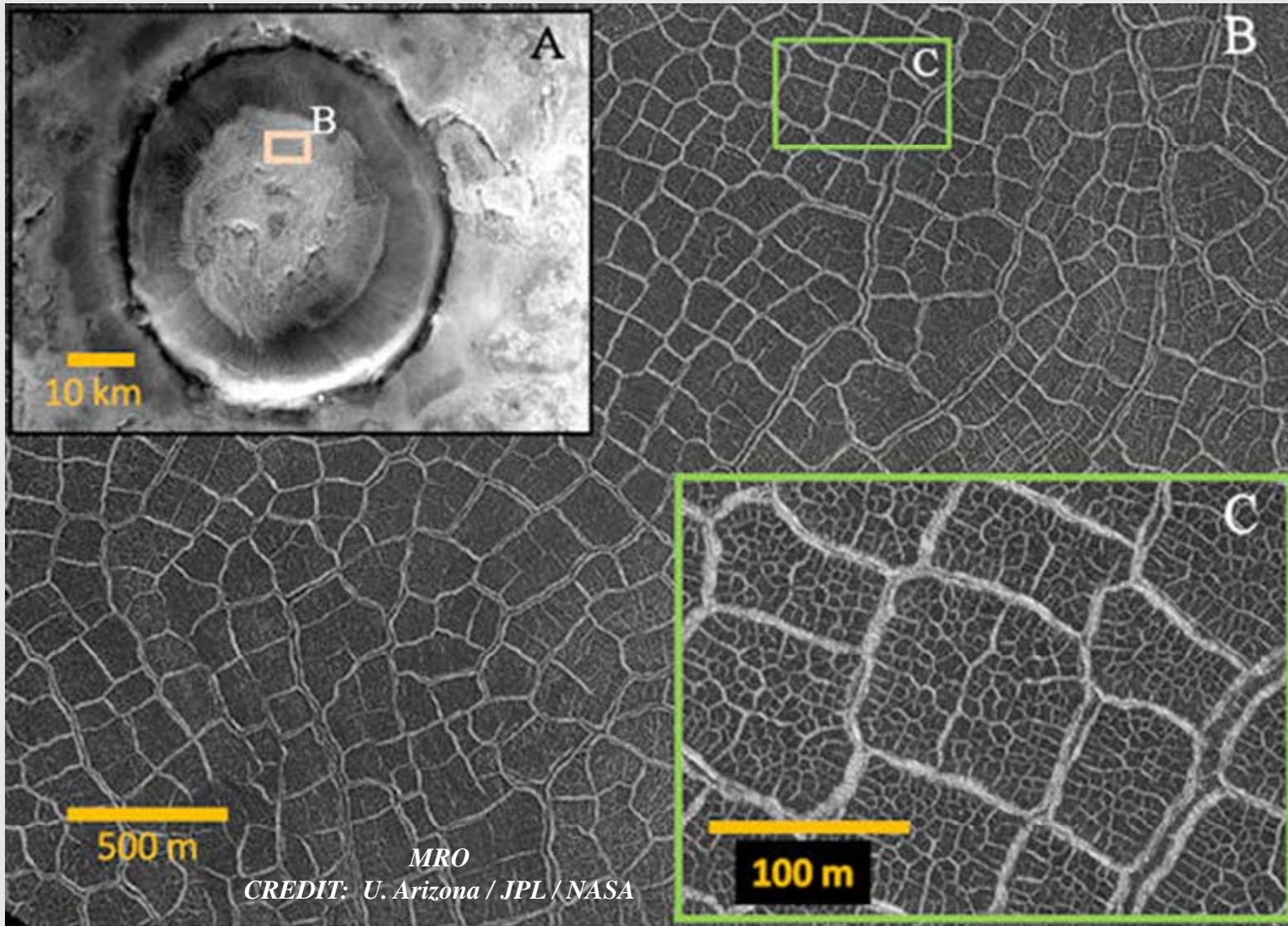




# Mars Patterned Ground



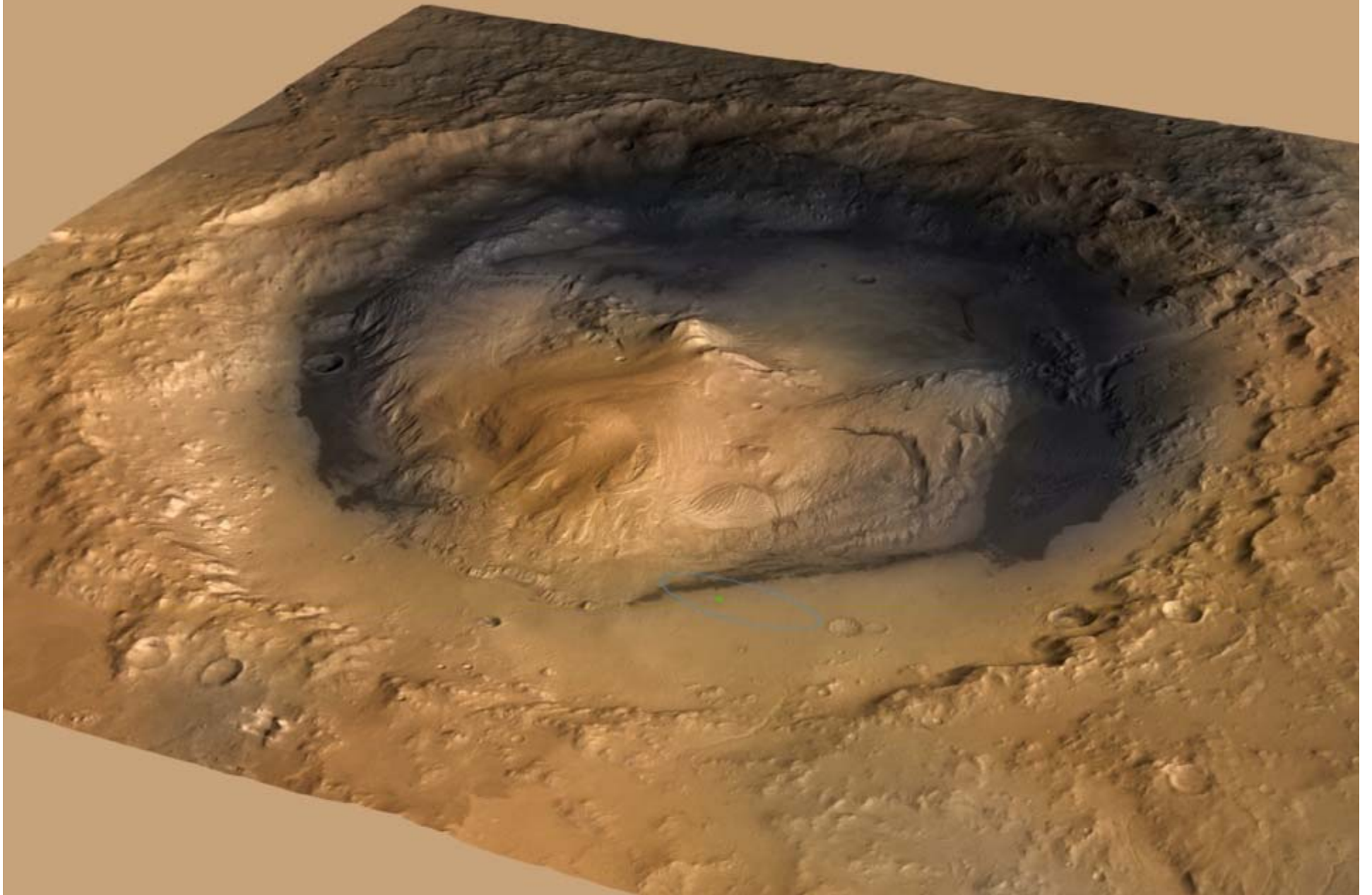
Solar System Exploration @ 50



October 25, 2012

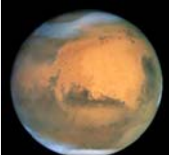
Credit: NASA / JPL / University of Arizona 3

# *Gale Crater and Mount Sharp*





# *Foothills of Mt. Sharp*

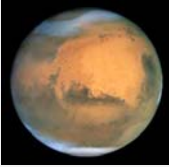


**View to North**

*Credit: MastCam / MSSS / JPL / NASA*

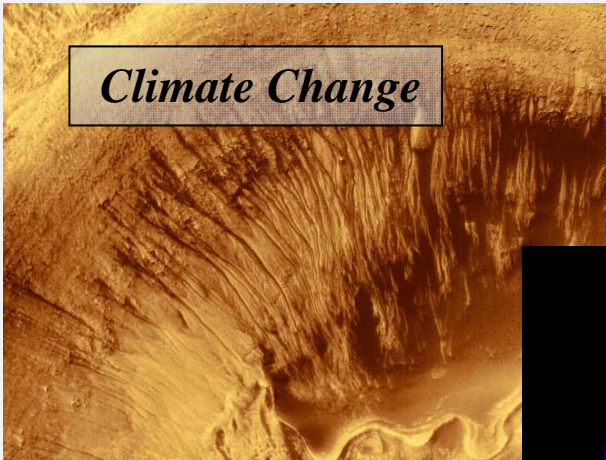


# Mars: A Complex Planet

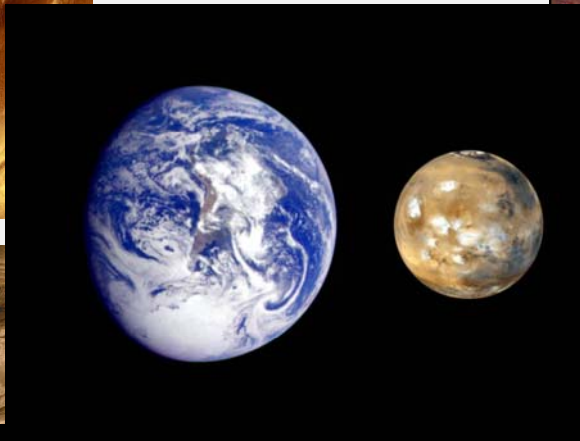


*Solar System Exploration @ 50*

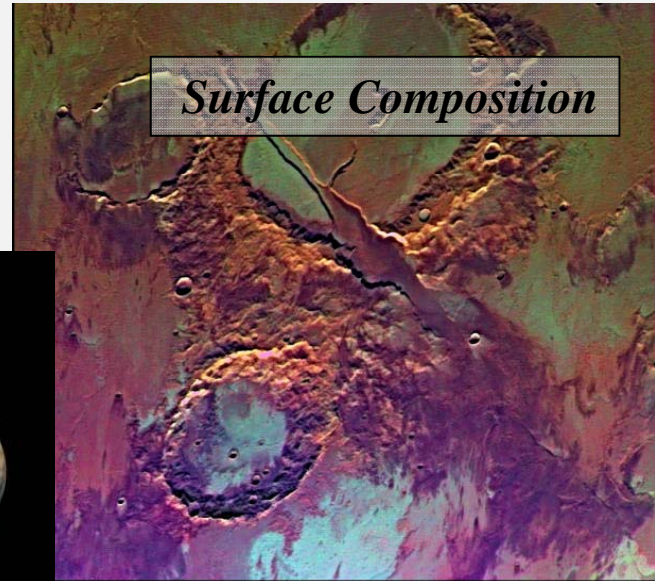
*Climate Change*



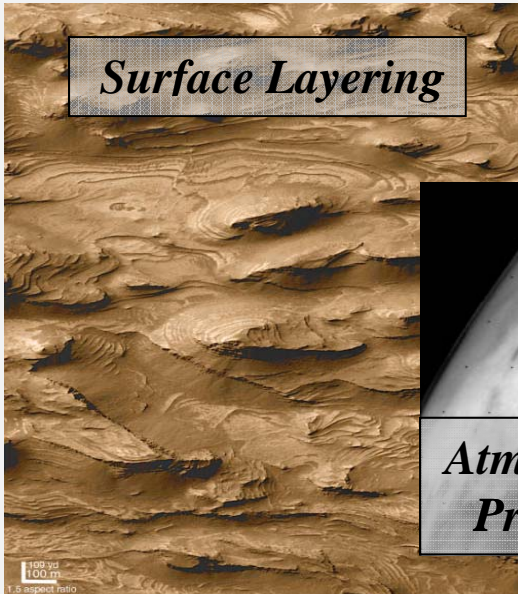
*Comparative Planetology*



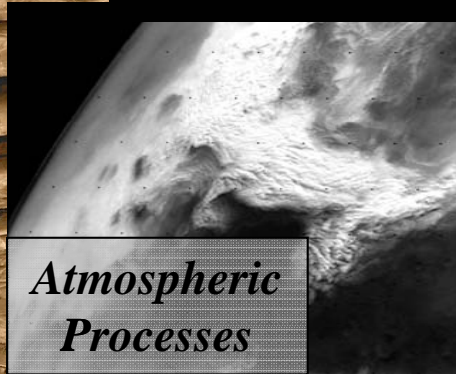
*Surface Composition*



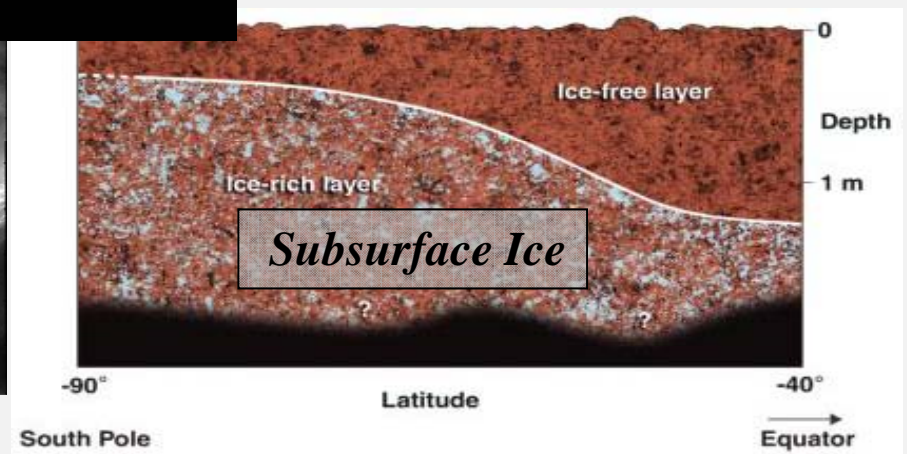
*Surface Layering*



*Atmospheric Processes*



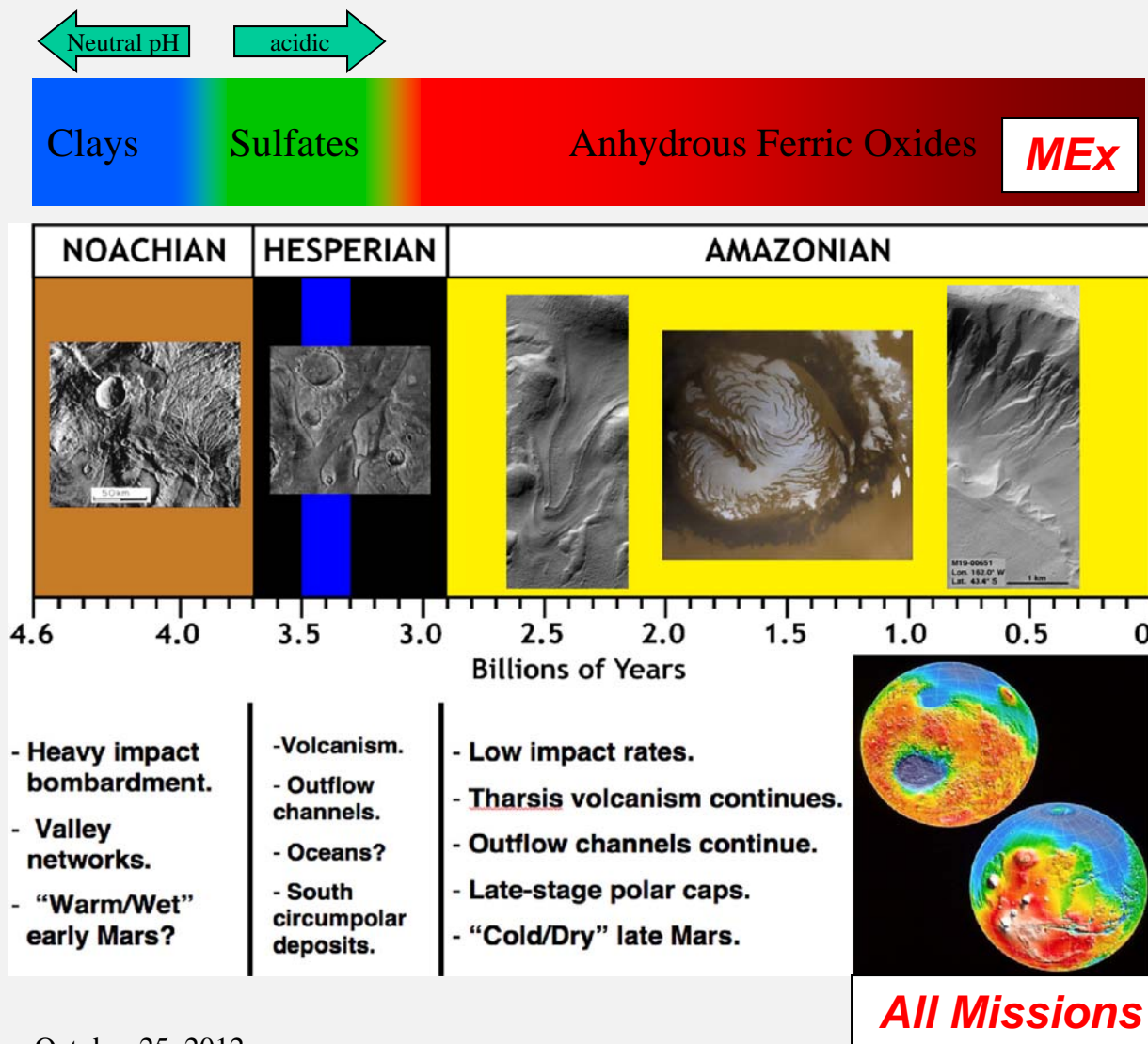
*Subsurface Ice*



# Mars Planetary Evolution



Solar System Exploration @ 50



## □ Hydrus Mineralogy Changed Over Time

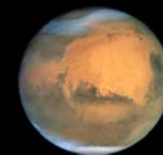
- Phyllosilicate minerals (smectite clay, chlorite, kaolinite...) formed early
- Evaporates dominated by sulfate formed later with opal/hydrated silica
- Few hydrated mineral deposits since

## □ Evolution of Aqueous, Fluvial and Glacial, Morphology with Time

- Valley networks, lake systems
- Gullies
- Viscous flow, glaciers, latitude dependant mantle

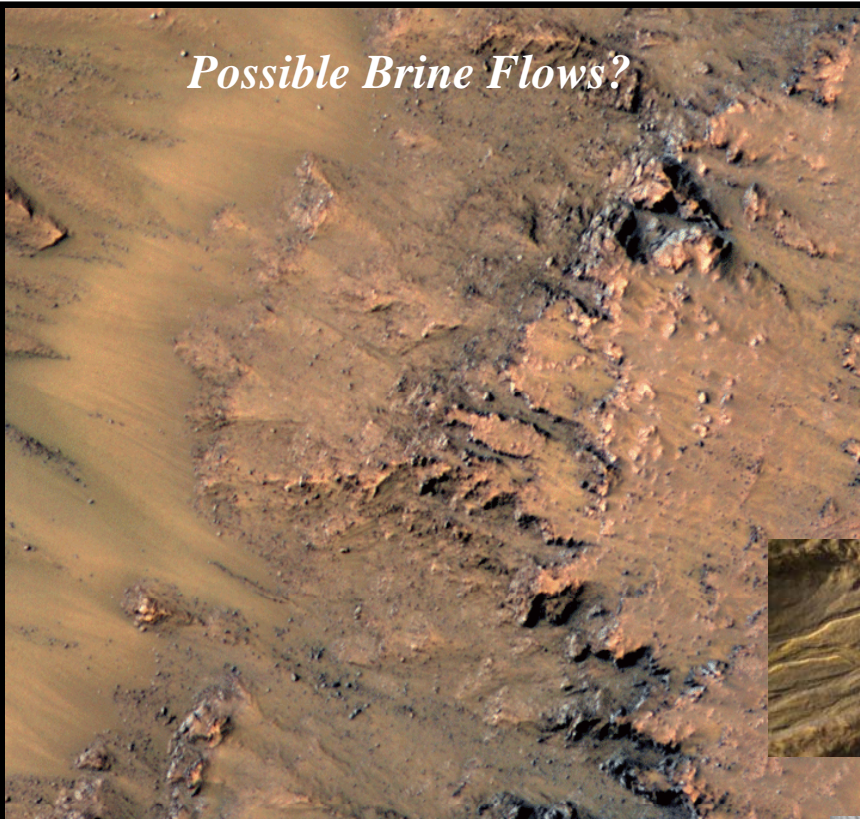


# *Mars: A Planet Changing Today*



*Solar System Exploration @ 50*

*Possible Brine Flows?*



*Global Dust Storm*



June 26, 2001



September 4, 2001

*New Gully Flows*



*Polar Cap Extent*

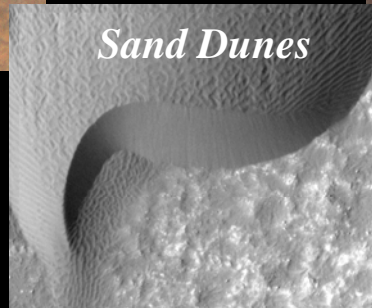


March 1999

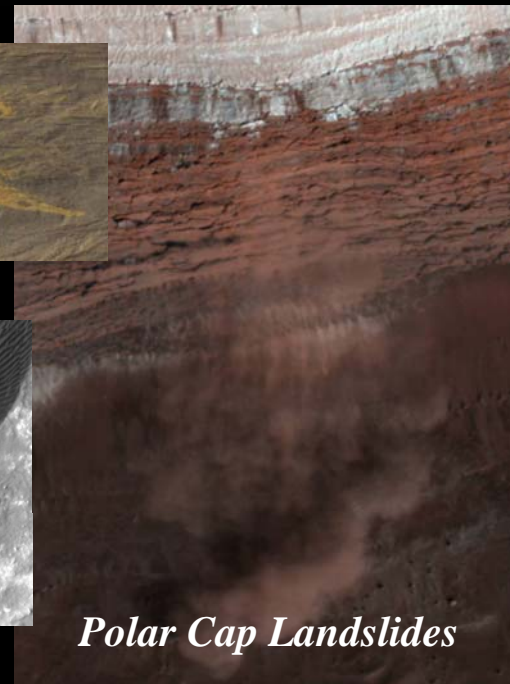


January 2001

*Sand Dunes*



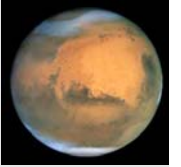
*Polar Cap Landslides*



*Credits: HST / MRO STSci / U. Arizona / JPL / NASA*



# Why Mars?



*Solar System Exploration @ 50*

- ***Mars: An Abode for Life?***
  - Mars is in the “habitable zone” with an early climate that had liquid water and sunlight on its surface, with basic elements to utilize
  - If life originated there, does it still exist? If life did not originate there, why not?
- ***Mars: Comparative Study with Earth***
  - The climate of Mars has changed profoundly over time
  - The record of that change is preserved in its surface morphology and composition. Mars was once wetter--and possibly warmer--with a much more active hydrological cycle
- ***Mars: A destination?***
  - Of all the planets, Mars is the most accessible
  - Astronauts could walk on its surface by-mid century



# Robots and Humans

EXPLORATION DISCOVERY

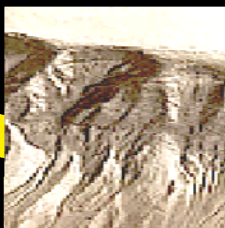
Climate History



Sample Selection



Ancient Water



Validate Paleo-Life

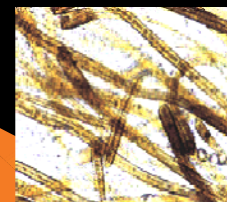


*3<sup>rd</sup> Wave of Space Exploration?*

Resources



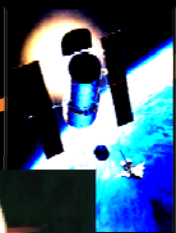
Extant Life?



ROBOTICS ROBOTICS ROBOTICS HUMANS ROBOTICS & HUMANS



Reconnaissance



Site Selection



Sample Selection



Return Sample



Field Studies



Deep Drilling





